

Amendment and Response

Applicant: Hong-Jyh Li, et al.

Serial No.: 10/799,910

Filed: March 12, 2004

Docket No.: 1550.115.101/2004P50029US

Title: ION IMPLANTATION OF HIGH-K MATERIALS IN SEMICONDUCTOR DEVICES

REMARKS

The following remarks are made in response to the Non-Final Office Action mailed November 29, 2007. Claims 1-5, 7-15, and 17 were rejected. With this Response, claims 1 and 15 have been amended. Claims 1-5, 7-15, and 17 remain pending in the application and are presented for reconsideration and allowance.

Claim Rejections under 35 U.S.C. § 102

The Examiner rejected claims 1-5, 7, 9, 10, 14, 15, and 17 under 35 U.S.C. § 102(b) as being anticipated by Rodder et al., U.S. Patent No. 6,251,761 ("Rodder").

Applicants submit that Rodder fails to teach or suggest the limitations recited by amended independent claim 1 including **a high-k material layer including an ionized species; and a conductive buffer layer including an ionized species, the conductive buffer layer being disposed between the high-k material layer and the gate electrode.**

Rodder discloses a gate stack 104 including a high-k dielectric 108 formed over a silicon substrate 102. Remote plasma nitridation of the high-k dielectric is performed to create a nitride layer 107 over the high-k dielectric. Conductive layer 110 is formed over the nitride layer 107 forming the gate electrode. (Abstract). Silicon dioxide layer 118 is subjected to remote plasma nitridation (RPN). RPN converts layer 118 from silicon dioxide to silicon-oxynitride layer 106. (Col. 3, lines 25-28). After RPN, high-K dielectric layer 108 is formed over silicon oxynitride layer 106. (Col. 3, lines 55-56). Following high-K formation, the stack is again subjected to the remote plasma process and a top portion of the high-K dielectric will be converted to a nitride 107. (Col. 4, lines 42-45). Gate electrode material 110 is deposited over the nitride layer 107. (Col. 4, lines 52-53). In another embodiment, gate electrode 110 comprises a layer of tungsten (W) overlying a layer of titanium-nitride (TiN). (Col. 4, lines 59-62).

The Examiner submits that the high-k dielectric layer 108 of Rodder teaches the *high-k material layer* recited by claim 1. (Office Action, page 2). High-k dielectric layer 108 of Rodder, however, does not include *an ionized species*. Rodder teaches that the top portion of the high-k dielectric material is converted to provide nitride 107. The remaining high-k dielectric layer 108 is not ion implanted with a species and therefore does not include an ionized species.

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The Examiner also submits that the gate electrode 110 comprising a metal layer overlying a layer of TiN of Rodder discloses *a conductive buffer layer* recited by claim 1. (Office Action, page 3). The layer of TiN of Rodder, however, does not include *an ionized species*. Both remote plasma processes disclosed in Rodder occur before gate electrode 110 including the layer of TiN is deposited. Therefore, the TiN layer is not ion implanted with a species and therefore does not include an ionized species.

For similar reasons as discussed above with reference to independent claim 1, Rodder also fails to teach or suggest the limitations recited by amended independent claim 15 **including a high-k gate dielectric layer including an ionized species; and a conductive buffer layer including an ionized species, the conductive buffer layer being disposed between the gate electrode and the high-k gate dielectric layer.**

In view of the above, Applicants submit that the above rejection of independent claims 1 and 15 under 35 U.S.C. §102(b) should be withdrawn. Dependent claims 2-5, 7, 9, 10, 14, and 17 further define patentably distinct independent claim 1 or 15. Accordingly, Applicants believe that these dependent claims are also allowable over the cited reference. Allowance of claims 1-5, 7, 9, 10, 14, 15, and 17 is respectfully requested.

Claim Rejections under 35 U.S.C. § 103

The Examiner rejected claims 8 and 11-13 under 35 U.S.C. § 103(a) as being unpatentable over Rodder.

Dependent claims 8 and 11-13 further define patentably distinct independent claim 1. Accordingly, Applicants believe that these dependent claims are also allowable over the cited reference. Allowance of claims 8 and 11-13 is respectfully requested.

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CONCLUSION

In view of the above, Applicants respectfully submit that pending claims 1-5, 7-15, and 17 are in form for allowance and are not taught or suggested by the cited references. Therefore, reconsideration and withdrawal of the rejections and allowance of claims 1-5, 7-15, and 17 is respectfully requested.

No fees are required under 37 C.F.R. 1.16. However, if such fees are required, the Patent Office is hereby authorized to charge Deposit Account No. 50-0471.

The Examiner is invited to contact the Applicants' representative at the below-listed telephone numbers to facilitate prosecution of this application.

Any inquiry regarding this Amendment and Response should be directed to Mark A. Peterson at Telephone No. (612) 573-0120, Facsimile No. (612) 573-2005. In addition, all correspondence should continue to be directed to the following address:

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Respectfully submitted,


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